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ABSTRACT

A great number of students, and a particularly high proportion of females, do not study mathematics beyond minimum high school requirements. Research indicates that segregation of mathematics classes may help reduce the incidence of female students dropping out of that subject. In an attempt to redress this situation, A. Y. Jackson Secondary School of North York, Ontario, elected to stream all grade 10 advanced mathematics classes by sex, beginning in 1984. This study evaluated the effects of the segregated classes on participation rates by sex, student attitudes, student achievement, and reactions of students, parents and teachers. The study was designed to be conducted over a 4-year period, so that the progress of the students could be monitored through grades 10-13. The results of the first year study showed that there may have been some changes in the attitude of certain students, and there may have been some changes in the achievement of some students. The largest percentage of comments made by parents and students reflected the belief that attitudes and achievement were not affected by segregated classes. Teachers were positive about the program. Appendices include a literature review and bibliography of three pages, and student and parent questionnaires. (JAZ)

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NORTH YORK BOARD OF EDUCATION

RESEARCH REPORT

EFFECT OF SEX-SEGREGATED MATHEMATICS CLASSES

ON STUDENT ATTITUDES AND ACHIEVEMENT IN MATHEMATICS:

A.Y. JACKSON SECONDARY SCHOOL

YEAR I

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
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Jim Macfarlane, Pat Crawford

September, 1985

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TABLE OF CONTENTS

		Page
I	INTRODUCTION	1
	Background	1
	Purpose of Study	1
	Methodology	2
	Development of Questionnaires/Interview Schedule	3
	Participants	4
	Findings	5
II	STUDENT ATTITUDES TOWARDS MATHEMATICS	7
	Mathematics Attitudes Scales	7
	Student, Parent and Teacher Perceptions of Changes in Attitude	11
	Career Aspirations of Students	13
	Student Participation Rates in Mathematics	15
	Summary	16
III	STUDENT ACHIEVEMENT IN MATHEMATICS	17
IV	PARENT, TEACHER AND STUDENT REACTIONS TO SEX-SEGREGATED MATHEMATICS CLASSES	20
	Students	20
	Parents	21
	Teachers	22
V	CHANGES IN TEACHING STYLE AND STRATEGIES AS A RESULT OF SEX-SEGREGATED MATHEMATICS CLASSES	24
VI	SUMMARY	25
VII	APPENDICES	27
	A Literature Review	27
	B Relationship between Mathematics Achievement and Attitudes	36
	C Student Reactions to Sex-Segregated Mathematics Classes	37
	D Parent Reactions to Sex-Segregated Mathematics Classes	41
	E Student Questionnaire	44
	F Student Questionnaire Items by Scale	52
	G Parent Questionnaire	55
	H Staff Interview	57

I INTRODUCTION

Background

Knowledge of mathematics has often been described as the "critical filter" for entrance into many occupations. Without such knowledge, many people are prevented from participating in a wide variety of challenging and rewarding careers. When students elect not to study mathematics much beyond minimum high school requirements, they are severely limiting the educational and occupational opportunities available to them. A large number of high school students are currently making such a decision and, among them, a particularly high proportion of females.

In an attempt to redress this situation, concerned staff members at A.Y. Jackson Secondary School elected to stream all grade 10 advanced mathematics classes by sex starting September 1984. A review of available literature indicates that segregation of mathematics classes may help to reduce the incidence of female students dropping out of that subject. Research suggests that without male students in their mathematics classes, females become less hesitant to work to the full of their ability: they need not be concerned about appearing "unfeminine" in front of their male peers by seeming too bright or ambitious. Moreover, all girl classes appear to encourage the development of strong peer support groups which are important in changing the perception of mathematics as a male domain and in affirming the appropriateness of mathematics for women.

A review of the literature concerning participation rates in mathematics, determining factors in mathematics achievement and participation, and intervention strategies may be found in Appendix A.

Students who enrolled in grade 10 advanced mathematics at A.Y. Jackson S.S. in September, 1984 were placed in sex-segregated mathematics classes and will continue in such classes until the end of grade 12. Furthermore, all students entering grade 10 advanced mathematics in future years will also be placed in segregated classes. Whenever possible, an attempt will be made to have teachers teaching classes of the same sex as themselves. During the 1984-85 school year, all classes of female students were taught by female teachers while all classes of male students were taught by male teachers.

Purpose of Study

Educational Research and Evaluation Services were requested to conduct an evaluation of the effects of the segregated classes at A.Y. Jackson S.S. Four questions provided the focus for the study:

1. To what extent do segregated classes change the participation rates of male and female students in mathematics courses?

2. How are students' attitudes towards mathematics affected by segregated classes?

3. How is students' achievement in mathematics affected by segregated classes?

4. What is the reaction of students, parents and teachers?

Methodology

The study will be conducted over a four year period in order that the progress of the students currently enrolled in grade 10 may be monitored up until the end of grade 13. It is anticipated that the effects of the segregated classes will become more evident in the later years as the discrepancy in participation rates becomes more pronounced in grades 12 and 13. This report presents data collected during the first year only.

In order to determine the extent to which possible changes at A.Y. Jackson are the result of segregated classes, a control group at another North York school was selected for purposes of comparison. The school is similar to A.Y. Jackson with respect to both the emphasis placed on academic courses and the socio-economic background of the student population.

Data collection procedures were developed by Educational Research and Evaluation Services in co-operation with staff members from A.Y. Jackson S.S. The procedures followed during the first year were:

- attitude questionnaires were administered to students in grade 10 advanced mathematics at A.Y. Jackson and the comparison school at the beginning and end of the 1984-85 school year

- the Mathematics Concepts and Applications sub-test of the Canadian Achievement Test (C.A.T.) Level 19, Form A was administered to students in grade 10 advanced mathematics at A.Y. Jackson and the comparison school at the end of May, 1985

- the grade 9 and 10 year-end mathematics marks (as reported by teachers) were collected for students enrolled in grade 10 advanced mathematics at A.Y. Jackson and the comparison school

- a questionnaire was sent to parents of students in grade 10 advanced mathematics at A.Y. Jackson in June, 1985

- teachers of the segregated classes at A.Y. Jackson were interviewed

- data were gathered regarding 1984-85 enrolment by sex in mathematics courses at A.Y. Jackson and the comparison school

In future years the data collection procedure will be as follows:

- the attitude questionnaire will be administered once at the end of each year to the students who remain in advanced mathematics at A.Y. Jackson and the comparison school

- the Mathematics Concepts and Applications sub-test will be administered each year to students who remain in advanced mathematics courses at A.Y. Jackson and the comparison school
- final year-end mathematics marks (as reported by teachers) will be collected for students at A.Y. Jackson and the comparison school
- interviews will be conducted with teachers at A.Y. Jackson who are teaching the first group of students to be placed in segregated classes
- data will be gathered regarding enrolment by sex in mathematics courses at A.Y. Jackson and the comparison school

Development of Questionnaires/Interview Schedule

The mathematics attitude questionnaire administered to students was designed to determine their attitudes towards mathematics, the extent to which their prospective career choices involve a knowledge of mathematics, and their reaction to sex-segregated classes (for students at A.Y. Jackson only).

The items which measure students' attitudes towards mathematics were taken from the Fennema-Sherman Mathematics Attitudes Scales. These scales assess important domain specific attitudes which have been hypothesized to be related to the learning of mathematics (see Literature Review in Appendix A) and include the following:

- attitude toward success in mathematics scale
- mathematics as a male domain scale
- mother/father scale
- teacher scale
- confidence in learning mathematics scale
- mathematics anxiety scale
- effectance motivation scale in mathematics
- mathematics usefulness scale

Fifty-one items were selected from the scales with the greatest number coming from those areas most likely to be affected by the introduction of segregated classes. The number of items coming from each scale is as follows:

	Number
mathematics as a male domain	8
attitude toward success in mathematics	8
confidence in learning mathematics	6
mathematics anxiety	6
usefulness of mathematics	5
effectance motivation in mathematics	5
teacher	5
mother	4
father	4

A list of the items included in each attitude scale may be found in Appendix F.

Each item features a statement regarding mathematics. Students were asked to indicate the extent to which they agreed or disagreed with the statement by selecting a point on a six-point scale from "strongly agree" to "strongly disagree". Each response was assigned a score from one to six, with higher scores being given to responses that were considered to reflect positive attitudes towards mathematics. Average scores were calculated for each attitude scale and the higher the score, the more positive the attitude.

To determine the extent to which students' career plans involve a knowledge of mathematics, they were asked to consider a list of careers and select the one which most closely resembled that which they would most like to have.

Finally, students at A.Y. Jackson were asked to discuss the effects of the segregated classes and their reactions to them. In the questionnaire administered at the end of the school year students at both A. Y. Jackson and the comparison school were asked whether or not they intended to continue on in advanced mathematics.

A copy of the student attitude questionnaire may be found in Appendix E.

The questionnaire sent to parents of grade 10 advanced mathematics students at A.Y. Jackson was designed to determine their perceptions of the effectiveness of the sex-segregated classes. Questions were included regarding the classes' effect on their child's attitude and achievement in mathematics as well as the importance they place on their child's mathematics education and the extent to which they have become involved in her/his career planning. A copy of the questionnaire may be found in Appendix G.

Interviews were conducted with the teachers of grade 10 advanced mathematics at A.Y. Jackson in order to determine their perceptions of the effects of the segregated classes on the students, as well as to gather information regarding any changes which may have occurred in their teaching styles and expectations. A copy of the interview schedule may be found in Appendix H.

Participants

The following tables provide information on the number of students involved in each part of the study.

Attitude Survey

School	No. of Students					
	Sept/Oct. 1984			May 1985		
	female	male	total	female	male	total
A.Y. Jackson	151	166	317	139	139	278
Comparison School	125	127	252	121	114	235

Mathematics Achievement

School	No. of Students								
	Gr. 9 mark			Gr. 10 mark			C.A.T. Test		
	female	male	total	female	male	total	female	male	total
A.Y.Jackson	152	170	322	157	169	326	126	128	254
Comparison School	134	136	270	136	140	276	113	111	224

The six permanent staff members at A.Y. Jackson teaching the segregated classes were interviewed, as well as two other teachers (one supply, one student) having had some experience with the classes.

Information was also gathered regarding the teaching experience of the staff members at A.Y. Jackson and the comparison school. As the table below indicates, staff at both schools have been teaching mathematics for approximately the same amount of time, although those at the comparison school have more total teaching experience. The teachers at the comparison school have also been at their school for a longer period of time.

School	Average No. years teaching	Average No. years teaching mathematics	Average No. years teaching at present school
A.Y. Jackson	10.8	10.0	4.7
Comparison School	15.7	11.5	7.3

Three hundred and twenty-eight questionnaires were sent to parents of students in the segregated classes; responses were received from 135, a response rate of 41%. Eighty-eight percent of parents indicated that they were aware that the classes had been segregated.

Findings

The findings are organized and presented in the following sections:

- Student Attitudes Towards Mathematics
- Student Achievement in Mathematics
- Parent, Teacher and Student Reactions to Sex-Segregated Mathematics Classes

- Changes in Teaching Style and Strategies as a Result of Sex-Segregated Mathematics Classes
- Summary

The Appendices include:

- a review of the literature concerning participation rates in mathematics, determining factors in mathematics achievement and participation, and intervention strategies
- a discussion of the relation between mathematics achievement and attitudes based on the findings of this report
- a detailed examination of comments made by students and parents regarding sex-segregated classes
- copies of the questionnaires/interview schedule used
- a list of the student questionnaire items included in each attitude scale

II STUDENT ATTITUDES TOWARDS MATHEMATICS

1. Mathematics Attitudes Scales

Students were asked to indicate the extent to which they agreed or disagreed with a series of statements regarding their attitudes towards mathematics. Responses were assigned a score from one to six, with higher scores reflecting more positive attitudes.

An analysis of the data was carried out with the assistance of staff at the Institute for Social Research, York University. Average scores on the pre- and post-tests were calculated for each of the nine attitude scales and comparisons were made between the scores of males and females at each school as well as between the scores of students at A.Y. Jackson and the comparison school. While differences did appear between males and females on certain scales, they were usually consistent from pre- to post-tests and did not vary from school to school. Changes which occurred in the scores of the students at A.Y. Jackson did not differ significantly from the changes in the scores of students at the comparison school. The fact that there were so few differences between the two schools would tend to indicate that a good match was obtained.

On the tables that follow, average scores are listed for each of the attitude scales. Where there are significant differences between scores (measured at the .05 level) these are discussed, otherwise it may be assumed that the scores are not significantly different. It should be noted that most scores are relatively high, thus indicating that the students generally hold very positive attitudes towards mathematics. Whether or not such positive attitudes are particular to the advanced-level courses at these two schools will be investigated next year through a survey of students in general level programs and in schools with different student populations. With attitudes already being so positive at A.Y. Jackson and the comparison school, it was unlikely that significant improvements in student attitude would occur. What may perhaps prove to be more significant in the long run will be the extent to which female attitudes remain constant or decline as they progress through the grades. As the literature indicates, there is a tendency for female students to adopt increasingly negative attitudes towards mathematics as they progress through the grades.

a) Attitude Towards Success in Mathematics Scale

The Attitude Towards Success in Mathematics Scale was designed to measure the degree to which students anticipate positive or negative consequences as a result of success in mathematics. Students demonstrate a fear of success by anticipating negative consequences or by lack of acceptance or responsibility for the success, e.g. "It was just luck."

School	Female		Male	
	Pre	Post	Pre	Post
A.Y. Jackson	5.02	5.17	4.89	5.00
Comparison School	5.21	5.30	5.03	5.01

On the pre-test, there was a significant difference between the average scores of male and female students as well as between the scores of students at A.Y. Jackson and the comparison school. Female students at the two schools were more likely to anticipate positive consequences as a result of success in mathematics, as were the students at the comparison school.

On the post-test, female students at both schools were still more likely to anticipate positive consequences than males, although there was no longer a significant difference between the scores of the students at the comparison school and A.Y. Jackson. Although most scores improved on the post-test, the magnitude of the increase was not significantly different from one school to the other.

b) Mathematics as a Male Domain Scale

The Mathematics as a Male Domain Scale is intended to measure the degree to which students see mathematics as a male, neutral or female domain in the following ways:

1) the relative ability of the sexes to perform in mathematics

2) the masculinity/femininity of those who achieve well in mathematics

3) the appropriateness of this line of study for the two sexes

School	Female		Male	
	Pre	Post	Pre	Post
A.Y. Jackson	5.61	5.61	5.04	5.06
Comparison School	5.60	5.63	5.23	5.25

On both the pre- and post-tests, female students were more likely to see mathematics as being equally suitable for men and women than were male students.

c) Confidence in Learning Mathematics Scale

The Confidence in Learning Mathematics Scale is intended to measure confidence in one's ability to learn and to perform well on mathematical tasks. The dimension ranges from distinct lack of confidence to definite confidence.

School	Female		Male	
	Pre	Post	Pre	Post
A.Y. Jackson	4.77	4.56	4.84	4.65
Comparison School	4.51	4.49	4.95	4.83

The average scores for this scale indicate that the male students have more confidence in their ability to learn and perform well on mathematical tasks.

d) Mathematics Anxiety Scale

The Mathematics Anxiety Scale is intended to measure feelings of anxiety, dread, nervousness and associated bodily symptoms related to doing mathematics. The dimension ranges from feeling at ease to those of distinct anxiety.

School	Female		Male	
	Pre	Post	Pre	Post
A.Y. Jackson	4.31	4.17	4.23	4.08
Comparison School	4.03	4.03	4.27	4.37

There were no significant differences between groups on this scale.

e) Mathematics Usefulness Scale

The Mathematics Usefulness Scale was designed to measure students' beliefs about the usefulness of mathematics currently and in relationship to their future educational, vocational and other activities.

School	Female		Male	
	Pre	Post	Pre	Post
A.Y. Jackson	5.05	5.08	5.11	4.95
Comparison School	4.85	4.78	5.00	4.96

There were no significant differences between groups on this scale.

f) Effectance Motivation Scale in Mathematics

The Effectance Motivation Scale in Mathematics is intended to measure effectance as applied to mathematics. The dimension ranges from lack of involvement in mathematics to active enjoyment and seeking of challenge.

School	Female		Male	
	Pre	Post	Pre	Post
A.Y. Jackson	4.40	4.06	4.26	3.83
Comparison School	4.42	3.86	4.33	3.70

There were no significant differences between groups on this scale.

g) Teacher Scale

The Teacher Scale was designed to measure students' perceptions of their teachers' attitudes towards them as learners of mathematics. It includes the teachers' interest, encouragement and confidence in the student's ability.

School	Female		Male	
	Pre	Post	Pre	Post
A.Y. Jackson	4.52	4.52	4.22	4.28
Comparison School	4.29	4.33	4.18	4.32

On the pre-test, females at both A.Y. Jackson and the comparison school perceived their teachers as having more positive attitudes towards them as learners of mathematics than did the males. By the post-test, however, the gap had narrowed and there was no longer any significant difference between the scores of the two sexes.

h) Mother and Father Scales

The Mother and Father Scales were designed to measure students' perceptions of their mother's/father's interest, encouragement and confidence in the student's ability. It also includes the student's perception of their mother's/father's example as an individual interested, confident and aware of the importance of mathematics.

Mother Scale

School	Female		Male	
	Pre	Post	Pre	Post
A.Y. Jackson	5.11	5.21	5.18	5.17
Comparison School	4.94	4.99	5.08	5.10

Father Scale

School	Female		Male	
	Pre	Post	Pre	Post
A.Y. Jackson	5.19	5.14	5.12	5.06
Comparison School	5.09	5.00	5.12	5.08

There were no significant differences between groups on these scales.

i) Summary

An analysis of student responses indicates that while there were some changes in the attitudes of students at A.Y. Jackson, they did not differ significantly from the changes in the attitudes of students at the comparison school. This would tend to suggest that the segregated classes had no significant effect on student attitudes as measured by the Mathematics Attitudes Scales.

There were no significant differences between the attitudes of students at A.Y. Jackson and the comparison school although some discrepancies did appear between the responses of males and females:

1. The female students at A.Y. Jackson and the comparison school were more likely to anticipate positive consequences as a result of success in mathematics.

2. The female students were more likely to see mathematics as being equally suitable for men and women.

3. The male students appeared to have more confidence in their ability to learn and perform well on mathematical tasks.

2. Student, Parent and Teacher Perceptions of Changes in Attitude

On the pre-test, students at A.Y. Jackson were asked if they thought segregated classes would be effective in improving students' attitudes towards mathematics. On the post-test, they were asked if they thought that segregated classes had been effective in improving attitudes. Their responses were as follows:

Pre-Test

Sex	Yes %	No %	Don't Know %	No Response %
Female	32	39	28	1
Male	27	46	26	2
Total	29	43	27	1

Post-Test

Sex	Yes %	No %	Don't Know %	No Response %
Female	30	37	29	3
Male	17	57	24	3
Total	24	47	27	3

At the beginning of the school year, 29% of male and female students indicated that they thought that segregated classes would be effective in improving students' attitudes. Females were slightly more positive in their responses than males.

By the end of the year, a quarter of all students indicated that the classes were helpful in improving attitudes. Although the responses of female students remained basically the same, there was a substantial decrease in the number of males who gave positive responses.

It is important to note that on both the pre- and post-tests over one-quarter of all students responded "don't know".

Parents were also asked if they felt that segregated classes were effective in improving students' attitudes towards mathematics. Their responses were as follows:

	Yes %	No %	Don't Know %	No Response %
Parents of males	23	49	28	-
Parents of females	33	36	29	2
Total	28	43	28	1

Twenty-eight percent of all parents indicated that they felt that segregated classes were effective in improving attitudes. The parents of females were more likely to see the classes as being effective. Again, a large proportion of respondents answered "don't know".

Teachers were also asked to discuss the effect that segregated classes have had on student attitude. Although the teachers of all-male classes indicated that there had been no changes, teachers of female classes all felt that the students were more relaxed and less hesitant to ask questions or volunteer answers.

> "The pressure is now off - it doesn't matter how they appear in class. They're no longer afraid of appearing stupid or too smart."

According to the teachers, this situation is especially advantageous to students having problems as they are usually the most reluctant to participate in mixed classes.

3. Career Aspirations of Students

On both the pre- and post-tests, students at A.Y. Jackson and the comparison school were asked to select the career which most closely resembled the one they would like to have. A list of over 40 careers was provided, as well as a space where students could add any career not already included. For the purposes of analysis, the careers were grouped according to the amount of mathematics they require.* The students' responses are presented in the tables that follow.

On the pre-test the females at A.Y. Jackson were less likely to aspire to careers requiring grade 13 mathematics than the females at the comparison school (31% as opposed to 38%). The same situation was apparent with respect to male students as well: 47% of the male students at A.Y. Jackson aspired to careers requiring grade 13 mathematics as opposed to 60% of male students at the comparison school. By the post-test, however, there was no significant difference between the same sexes at the two schools. While the career aspirations of the students at the comparison school remained relatively unchanged, a greater number of students of both sexes at A.Y. Jackson listed careers requiring grade 13 mathematics on the post-test than was the case for the pre-test.

On both the pre- and post-tests, male students were more likely to select careers requiring grade 13 mathematics. This difference between the sexes is somewhat surprising as both sexes had given similar responses on the Mathematics Usefulness Scale.

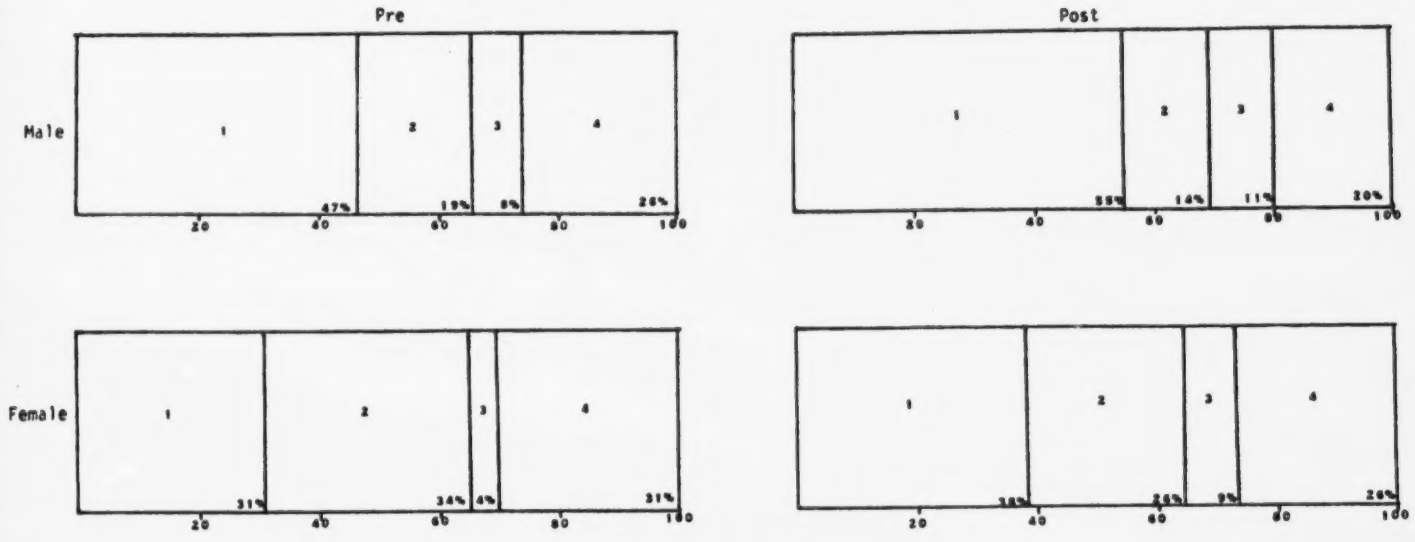
The parents of students at A.Y. Jackson were asked if they had discussed career possibilities with their children. An overwhelming majority indicated that they had, with no significant difference existing between the responses of the parents of male and female students.

Parents were also asked to indicate how important it was for their child to study mathematics. Although over four-fifths of all parents stated that it was "very important", parents of males were more likely to do so than parents of females (91% as opposed to 77%). The remaining parents all felt, however, that mathematics was at least "somewhat important".

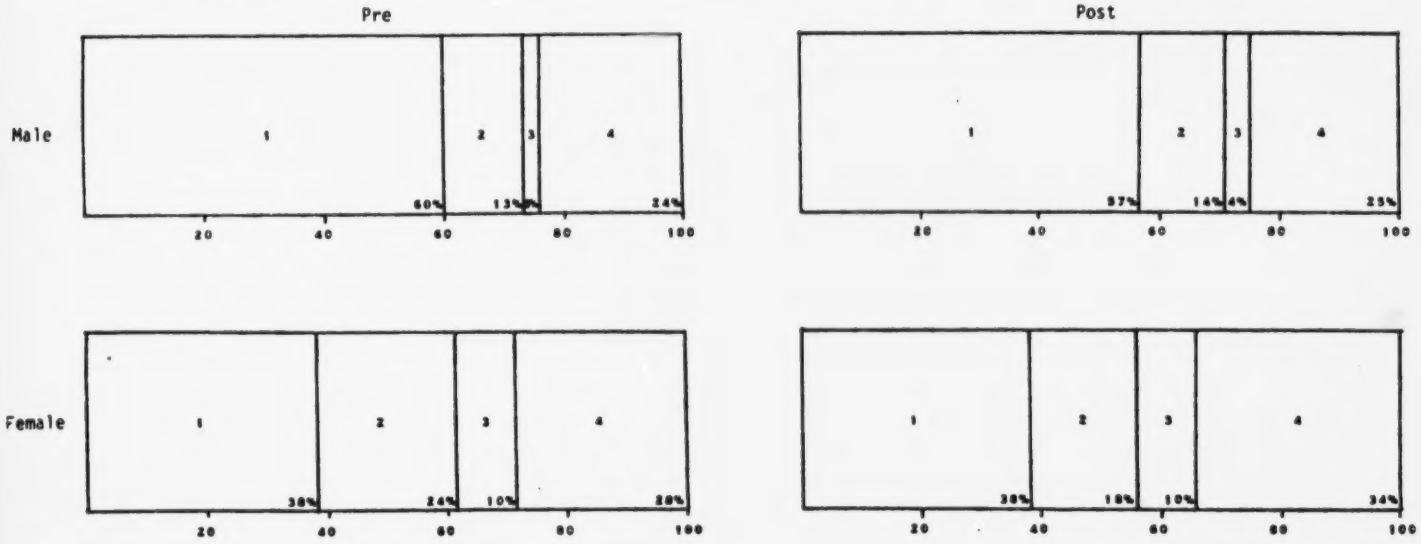
* see Toronto Board of Education, Mathematics: The Invisible Filter. Toronto Board of Education, 1983, p. 33.

Extent to Which Career Aspirations of Students Involve a Knowledge at Mathematics

A. Y. Jackson Secondary School



Comparison School



1. Grade 13 mathematics required
2. Grade 13 mathematics recommended
3. Grade 12 mathematics required
4. Grade 11 mathematics or less

4. Student Participation Rates in Mathematics

In order to asses the effect that segregated classes have on student participation rates in mathematics, data were gathered regarding current enrolment at all levels at both A.Y. Jackson and the comparison school. These data will serve as a basis for comparison with future enrolment figures.

Male/Female Composition of Mathematics Courses 1984/85

	A.Y. Jackson		Comp. School	
	Male	Female	Male	Female
General Level	%	%	%	%
Grade 10	40	60	50	50
11	43	57	22	78
11 Computer Science	67	33	N/A	
12	45	55	48	52
Total	44	56	40	60
Advanced and Enriched Levels				
Grade 10	52	48	53	47
11	52	48	54	46
11 Computer Science	65	35	61	39
12	52	48	54	46
12 Computer Science	81	19	92	8
13 Algebra	81	19	75	25
13 Calculus	58	42	59	41
13 Functions and Relations	55	45	55	45
13 Investment	57	43	N/A	
Total	56	44	55	45
TOTAL	54	46	56	44

As the above data indicate, the current enrolment patterns at the two schools are quite similar.

Students at both A.Y. Jackson and the comparison school were asked whether they planned to take mathematics the following year and if yes, at what level. Their responses were as follows:

Sex	A.Y. Jackson					Comparison School				
	Yes			No	N.R.	Yes			No	N.R.
	Adv. %	Gen. %	N.R. %	%	%	Adv. %	Gen. %	N.R. %	%	%
Female	88	5	3	-	4	89	2	-	-	9
Male	91	4	-	-	5	92	3	1	2	2
Total	90	4	2	-	4	91	2	-	1	6

These responses suggest that in 1985-86, the male/female composition in grade 11 advanced mathematics at A.Y. Jackson will be 51:49 and 50:50 at the comparison school. As the present ratios for grade 11 advanced mathematics are 52:48 at A.Y. Jackson and 54:46 at the comparison school, the projected enrolment represents a decrease in the disparity between male and female participation at both schools.

5. Summary

The analysis of data regarding student attitudes towards mathematics appears to indicate that there may have been some changes in the attitudes of certain students as a result of the segregated classes. Although the attitude scales did not reveal any significant changes, a quarter of all students at A.Y. Jackson reported that the classes had been effective in improving their attitudes, with females responding more positively than males. Twenty-eight percent of parents also agreed that the classes had been helpful, while teachers of all-female classes noted that the students were more relaxed and less hesitant to ask questions or volunteer answers.

Over the course of the year, both male and female students at A.Y. Jackson appeared to become more interested in careers requiring grade 13 mathematics. While the career aspirations of students at the comparison school remained relatively unchanged, a greater number of students at A.Y. Jackson listed careers requiring grade 13 mathematics on the post-test than had been the case on the pre-test. A more equal proportion of males and females in both schools plan to take grade 11 advanced mathematics in 1985/86 than was the case in 1984/85.

III STUDENT ACHIEVEMENT IN MATHEMATICS

In order to examine the impact of segregated classes on student achievement, the final grade 9 and 10 mathematics marks were collected for students at both A.Y. Jackson and the comparison school. The grade 10 marks at A.Y. Jackson were based on a common set of tests administered to all students. In order to control for differences in marking schemes between the two schools, a C.A.T. mathematics subtest was administered to students at both schools at the end of the school year.

A table showing the average grade 9 and 10 marks for all students is presented below.

Sex	Average Mathematics Mark (%)			
	Grade 9		Grade 10	
	A.Y. Jackson	Comp. School	A.Y. Jackson	Comp. School
Female	70	72	67	73
Male	67	67	63	70

An analysis of the grade 9 marks reveals no significant difference between the male and female students at A.Y. Jackson or between the students at A.Y. Jackson and the comparison school. There was a difference between the male and female students at the comparison school, however, with females having somewhat higher marks.

In grade 10, differences appeared between the marks of male and female students at A.Y. Jackson in favour of the females. There was also a difference between the students at the two schools: students at the comparison school had higher marks than those at A.Y. Jackson. The extent of the decrease in the marks of students at A.Y. Jackson from grades 9 to 10 did not differ significantly from one sex to the other, however. There was no longer a significant difference between the marks of the male and female students at the comparison school.

While the grade 10 marks might suggest that the students at A.Y. Jackson are achieving at lower levels, there was no difference between the results of the students at the two schools on the C.A.T. mathematics sub-test. There was also no significant difference between the male and female students at either of the schools. The average scores on the sub-test were as follows:

	A.Y. Jackson	Comp. School
Female	29.9	29.4
Male	30.3	30.5

On the questionnaire administered in the fall, students at A.Y. Jackson were asked if they thought segregated classes would affect the level of achievement of students. At the end of the year, they were asked if they thought that segregated classes had been effective in improving students' achievement in mathematics. Their responses were as follows:

	Pre-Test			
Sex	Yes %	No %	Don't Know %	No Response %
Female	31	42	25	1
Male	28	40	30	2
Total	30	41	27	2

	Post-Test			
Sex	Yes %	No %	Don't Know %	No Response %
Female	29	42	25	4
Male	20	50	26	4
Total	24	46	26	4

At the beginning of the school year, 30% of all students indicated that they thought that segregated classes would affect their level of achievement. By the end of the year, one-quarter of the students indicated that the classes were effective in improving achievement. Although the responses of the female students remained basically the same from pre to post, there was a decline in the number of males who gave positive responses.

It is important to note, however, that on both the pre- and post-tests, over one-quarter of all students responded "don't know".

Parents were also asked if they felt that segregated classes were effective in improving students' achievement in mathematics. Their responses were as follows:

	Yes %	No %	Don't Know %	No Response %
Parents of males	33	51	16	-
Parents of females	29	45	24	2
Total	31	48	20	1

Thirty-one percent of parents indicated that they felt that segregated classes were effective in improving achievement, a more positive response than that of their children. One-fifth of parents responded "don't know".

Teachers were also asked to discuss the effect segregated classes have had on student achievement. They all responded either that there had been no change or that they didn't know.

IV PARENT, TEACHER AND STUDENT REACTIONS TO SEX-SEGREGATED MATHEMATICS CLASSES

1. Students

On both the pre-and post-tests, students at A.Y. Jackson were asked to discuss the effectiveness of segregated classes in improving attitudes and achievement. They were also given the opportunity to make any other comments they felt were appropriate regarding the segregated classes. The most commonly made responses appear below, while a complete listing of responses and selected quotations may be found in Appendix C.

	Pre		Post	
	M. %	F. %	M. %	F. %
Positive Comments				
. students feel more comfortable, relaxed in segregated classes. They don't have to worry about being embarassed by asking questions, giving answers in front of members of the opposite sex	4	28	7	32
. fewer distractions, easier to concentrate on your work	24	11	14	4
. segregated classes are a good idea, would like them to continue	2	11	4	7
. achievement has improved this year	-	-	1	10
Negative Comments				
. segregated classes are unnecessary, boring, a bad idea - mixed classes are better, more interesting.	21	19	31	14
. classes are noisier, more unruly without the opposite sex/students work better in mixed classes, try to impress the opposite sex	1	5	14	14
. more challenge, competition in mixed classes	2	3	2	5
Neutral Comments				
. attitudes and achievement are not affected by segregated classes - they depend on the individual's ability and motivation, not on who's in her/his class	36	43	25	31
. effect of segregated classes depends on the individual - some have found them helpful, while to others they have made no difference	1	11	-	12
. haven't given segregated classes much thought, don't care one way or another	2	4	4	2

The above comments appear to indicate that the largest proportion of students does not believe that attitudes and achievement are affected by segregated classes. It is interesting to note, however, that fewer students made such a comment on the post-test than was the case for the pre-test. The remaining responses reflected considerable differences of opinion between male and female students. On the post-test, males were more likely than females to indicate that the classes were unnecessary/boring/a bad idea (31% as opposed to 14%). These figures represent an increase for males over the year and a decrease for females. A greater number of females than males indicated that they felt more comfortable and relaxed in segregated classes, while males were more likely to consider the classes worthwhile because of fewer distractions and improved concentration.

2. Parents

The parents of students in segregated classes at A.Y. Jackson were asked to discuss the classes' effectiveness in improving their children's attitudes and achievement in mathematics. They were also given the opportunity to make any other comments they felt were appropriate regarding the segregated classes. The most commonly made responses appear below, while a complete listing of responses and selected quotations may be found in Appendix D.

	Parents of Males %	Parents of Females %	Total %
Positive Comments			
. students are less hesitant to answer questions, express difficulties and seek extra help. There is less pressure and therefore, classes are more relaxed, enjoyable	13	20	16
. segregated classes are a good idea, should be continued	13	12	13
. fewer distractions, easier to concentrate	14	12	13
. attitudes have improved, students are more confident	10	8	9
. achievement has improved, marks are higher this year	6	9	7
Negative Comments			
. segregated classes are unnecessary, a bad idea	16	17	16

	Parents of Males %	Females %	Total %
Neutral Comments			
. attitudes, achievement are not affected by segregated classes - they depend on student motivation, ability and teacher competence	46	38	42
. would be interested in seeing the results of this study/what's the evidence to support segregation of classes by sex?/ to prove any merit, a school with a solid control group is needed	7	6	7

The responses offered by parents were similar to those given by students, although they tended to be somewhat more positive. Although the largest proportion of parents indicated that they did not think that attitudes and achievement are affected by segregated classes, the majority of the remaining responses were favourable to the concept. Parents cited advantages such as less hesitancy to answer questions, express difficulties and seek extra help; fewer distractions; and improved attitudes and achievement. In general, there were few significant differences between the responses of the parents of male and female students.

Parents were also asked if, in general, segregated classes had been a positive experience for their children. Their responses were as follows:

	Yes %	No %	Don't Know %	No Response %
Parents of males	26	42	28	4
Parents of females	32	27	29	12
Total	29	35	28	8

The largest proportion of parents of female students indicated that the classes had been a positive experience for their child, while for the parents of male students it was the opposite. A large proportion of parents either didn't know or didn't respond (36%).

3. Teachers

The teachers of the segregated classes at A.Y. Jackson were asked to discuss the overall effectiveness of the program. In general, their responses were positive, showing a strong degree of support for the concept. Four of the teachers teaching all-female classes remarked on the positive effects of the program: the increased confidence, the more open atmosphere, a stronger commitment to pursue the study of mathematics, and an increased sensitivity to sex-stereotyping on the part of students, family and teachers. Three teachers (two teaching all-male classes and the third with experience with both) felt that it was a worthwhile experiment which entailed no negative consequences. Other comments were as follows:

	Teachers #
• segregated classes cannot help all students - some have developed such negative attitudes towards math that nothing can be done	2
• female students need more encouragement from their parents to pursue studies in non-traditional areas such as math	2
• segregation should be started much earlier when female students first start forming their ideas about mathematics	1
• students should have a choice as to whether or not they want to participate in segregated classes. Although they are effective for low-achieving, reserved students, the competition and challenge of mixed classes might be more advantageous for stronger students	1
• segregation is good but it probably won't accomplish what it's expected to do. It's not the solution. The problem is that girls choose careers which don't involve math - they must become more aware of women who work in fields which involve mathematics and understand that they are viable alternatives.	1
• female students will probably not benefit from segregation itself but from the issues it has raised, the awareness of why it was done.	1

V CHANGES IN TEACHING STYLE AND STRATEGIES AS A RESULT OF SEX-SEGREGATED MATHEMATICS CLASSES

Teachers were asked to discuss any changes which had been brought about in their teaching styles and strategies as a result of the segregated classes. Two male teachers mentioned that their style of delivery had become a bit "rougher", while three female teachers indicated that they felt more relaxed and could speak "more directly" to their students, focusing specifically on shortcomings characteristic of female students in mathematics. One female teacher stated that she could relate to her students better, especially when they were experiencing negative attitudes.

Several teachers mentioned that the segregated classes had made them more aware of the differing needs of male and female students in mathematics and that they could thus devote more effort to meeting them. For example, one teacher remarked that female students seem to require more approval and positive reinforcement than males and that as a result she now makes a greater attempt to provide encouragement and positive feedback. Many female mathematics students have a tendency to believe that their high achievement is due to "luck" rather than effort and ability so teachers try to counter this perception by continually proving to them that they are not only capable but can do well.

As teachers have become more aware of the different needs of their female and male students, they have also become more conscious of the role they play in perpetuating the perception of mathematics as a male domain. The effects of this new understanding are felt not only in the segregated classes, but also in the mixed classes which these teachers teach. Examples and tests are now more closely monitored to ensure that they contain elements taken from everyday life which both females and males can relate to. Despite the fact that male students in mathematics classes are more aggressive than the females, teachers are now ensuring that males and females get equal attention.

VI SUMMARY

Concern regarding the tendency of female students to drop mathematics at an early stage in their high school careers prompted staff members at A.Y. Jackson S.S. to stream all grade 10 advanced mathematics classes by sex starting September 1984. The students will continue in these classes until the end of grade 12. Research has suggested that such a procedure may indeed be effective in reducing the incidence of female students dropping out of mathematics. The purpose of this study has been to determine the success of the first year of this program, although its ultimate test will come in grades 12 and 13 with an examination of the female and male participation rates.

In evaluating the effectiveness of the segregated classes, this study has focussed on three main areas: attitude, achievement and perceptions.

The analysis of data regarding student attitudes towards mathematics appears to indicate that there may have been some changes in the attitudes of certain students as a result of the segregated classes. Although the attitude scales did not reveal any significant changes, a quarter of all students at A.Y. Jackson indicated that the classes had been effective in improving their attitudes, with females responding more positively than males. Twenty-eight percent of parents also agreed that the classes had been helpful, while teachers of all-female classes noted that the students were more relaxed and less hesitant to ask questions or volunteer answers. Over the course of the year, both female and male students at A.Y. Jackson became more interested in careers requiring grade 13 mathematics. While the career aspirations of students at the comparison school remained relatively unchanged, a greater number of students at A.Y. Jackson listed careers requiring grade 13 mathematics on the post-test than had been the case on the pre-test.

The analysis of data regarding student achievement in mathematics appears to indicate that there may have been some change in the achievement of certain students as a result of the segregated classes. This was not so much evident with respect to actual marks and test scores as it was regarding students' own perceptions. Although the marks of students at A.Y. Jackson fell significantly from grades 9 to 10 while those of students at the comparison school remained relatively stable, there was no difference between the scores of the schools on the C.A.T. Mathematics subtest. The extent of the decrease in the marks of students at A.Y. Jackson did not differ significantly from one sex to the other. Approximately one-quarter of all students at A.Y. Jackson indicated that the segregated classes had been effective in improving achievement, with females giving more positive responses than males. Thirty-one percent of parents also agreed that the classes had been helpful.

The largest percentage of comments made by parents and students reflected the belief that attitudes and achievement were not affected by the segregated classes. Respondents felt that such considerations as student ability, motivation, and teacher competence were more important. The remaining comments focused on positive and negative aspects of the program. Among the positive aspects, a more relaxed atmosphere in which students feel less

hesitant asking questions and volunteering answers, fewer distractions, and increased confidence. Respondents who made negative comments regarding the program stated that the classes were boring/ unnecessary/ a bad idea, or that they were noisier, more unruly.

Teachers were, in general, quite positive about the program. Those teaching all-female classes commented on the increased confidence, the more open atmosphere, the stronger commitment to pursue the study of mathematics and the increased sensitivity to sex-stereotyping. Teachers of all-male classes indicated that it was a worthwhile experiment with no negative consequences.

While the largest proportion of students did not appear to have been affected by the segregated classes, there was nevertheless a sizeable number who indicated that they had indeed benefitted. This was especially true of female students. Although the objective data (attitude scales, grade 9 and 10 marks, C.A.T. scores) did not reveal any changes, subjective data suggested that approximately one-quarter of all students had experienced improved attitudes and achievement as a result of the classes. One-third of the female students indicated that they appreciated the more relaxed atmosphere and were less hesitant to answer questions, express difficulties and seek extra help. These positive findings were supported by teachers' comments.

In addition to these positive findings, however, it is important to note the presence of certain negative reactions, particularly on the part of male students. The extent to which these reactions are actually a result of the segregated classes or simply a reflection of attitudes which would have been expressed regardless is difficult to ascertain. It would appear, though, that they had no negative effect on achievement or attitudes as measured by the Mathematics Attitudes Scales. Thus the findings of this report would tend to indicate that the program has been beneficial for a minority of students, while leaving the rest relatively unaffected.

APPENDIX A

Literature Review

Knowledge of mathematics has often been described as the "critical filter" for entrance into many occupations. Without such knowledge, many people are prevented from participating in a wide variety of challenging and rewarding careers. When students elect not to study mathematics much beyond minimum high school requirements, they are severely limiting the educational and occupational opportunities available to them. A large number of high school students are currently making such a decision and among them, a particularly high proportion of females.

Studies have shown that as females proceed through the grades, their participation in mathematics declines more sharply than that of males. While there are few significant sex differences in grade 11, by grades 12 and 13 a greater proportion of males than females are enrolled in mathematics courses. Grade 13 enrolment figures for mathematics in Ontario were gathered for the Second International Mathematics Study (1981/82): the results showed that 65% of grade 13 boys were enrolled in Functions and Relations, 62% in Calculus and 36% in Algebra; for girls the figures were 54%, 44% and 20% respectively (Raphael et al., 1984). When the male/female composition of the courses is examined, the disparity becomes even more obvious.

	Ontario (1982-83)		North York	
	Male %	Female %	Male %	Female %
Algebra	66.1	33.9	71.7	28.3
Calculus	59.3	40.7	63.1	39.2
Functions and Relations	56.7	43.3	59.1	40.9

(Source: Board of Education for the City of North York, Affirmative Action/ Women's Studies)

As the above table indicates, the situation in North York is comparable to that of the rest of the province.

The lack of participation of female students in high school mathematics courses translates into a similar situation at the university level. In 1980 in Ontario only 7% of the women enrolled in full-time study leading to a B.A. were in engineering and applied science, mathematics, and physical sciences. This represented only 11% of the total enrolment in engineering and applied science and 31% of the enrolment in mathematics and physical sciences (Toronto Board of Education, 1983).

Many observers contend that the disparity in the participation rates of male and female students is due to differing mathematical achievement. Numerous studies have in fact shown that males are more likely to obtain higher grade averages and superior standardized test scores than females. In 1974, after an extensive survey of research on gender differences, Maccoby and Jacklin concluded that "the two sexes are similar in their early acquisition of

quantitative concepts and their mastery of arithmetic in grade school. Beginning at about age 12 or 13, however, boys' mathematical skills improve faster than girls'." The results of the Second International Math Study also seem to point to the same conclusion: in Ontario the grade 13 boys scored higher than the girls on a significant number of questions from the Ontario Math Achievement Test (Raphael et al, 1984). The poorer performance of female mathematics students may therefore explain their lower participation rate, given that "mathematics achievement . . . [is] one of the most important predictors of . . . election of mathematics" (Daniels Pedro et al., 1981).

In recent years, however, this theory has come under increasing attack. As research methodology has become more refined, differences in mathematical achievement between the sexes have diminished. Where they do exist, they are usually small and therefore do not explain the large discrepancies in the participation rates. Moreover, the link between achievement and ability is tenuous at best. Variations from school to school and from country to country in the size of sex-related differences in achievement suggest that there are no innate differences in ability. Biological research has also failed to prove the existence of sex-differences in mathematical ability. While it is possible that males may have superior spatial ability, the link between it and mathematical ability has yet to be clearly understood.

In the absence of any evidence to indicate that sex differences in innate mathematical ability do exist, researchers have begun to investigate the influence of environmental factors on achievement and participation. Here the results have proven to be more conclusive. Studies have shown that the following factors have an effect on mathematical achievement and, more importantly, participation: fear of success, perception of mathematics as a male domain, attitudes of significant others (mother, father, teacher), confidence in learning mathematics, mathematics anxiety, and perceived usefulness of mathematics.

Many researchers contend that the single most important factor in determining participation in mathematics is the students' perception of its usefulness: the more students perceive it as being directly relevant to their academic and career goals, the more likely they are to continue to elect to study it. Numerous studies have shown that males are more likely than females to see mathematics as being important for their future goals; they are also more likely to name as career interests occupations which require mathematical training. These differences must obviously play an important part in determining the participation rates of males and females.

Another important factor which contributes to the differing participation rates is the student's confidence in her/his ability to learn mathematics. "Research has shown that expectancies for success are linked to important achievement-related behaviours, such as performance, task persistence, and task choice (for example, Battle, 1966; Stein and Bailey, 1973)" (Eccles Parsons et al., 1982). If the probability of achieving a successful outcome is uncertain, behaviour in that domain is less likely to persist (Daniels Pedro et al., 1981). Numerous studies have found female students to be less confident about their ability to learn mathematics than males and to underestimate their ability to solve mathematical problems even when there were no significant sex-related differences in achievement.

Females also appear to experience more anxiety when faced with situations involving mathematics. This anxiety can prevent students from learning and discourage them from continuing on in mathematics. One study concluded that "anxiety follows [perceived] usefulness as the second most important variable in the equation predicting mathematics plans" (Daniels Pedro et al., 1981).

The fact that many students perceive mathematics as being a male domain may serve to discourage some females from pursuing studies in that area and ultimately, from choosing a career which involves mathematics. Although most females indicate that studying mathematics is just as appropriate for women as it is for men, males stereotype it as a male domain to a significantly greater degree (Fennema, 1980). This belief is undoubtedly communicated to females in a number of subtle ways which influence their willingness to study mathematics, especially during adolescence when the cross-sex influence is particularly strong (Fennema, 1980). Moreover, many students believe that males are better at mathematics than females: a 1980 Ontario Ministry of Education study on sex-role stereotyping found that "a reasonable percentage of each sex group" felt that males perform "best" in mathematics (Cassie et al., 1980). In one study, female mathematicians were asked why so few women choose mathematics as a career. Seventy-three percent of respondents stated that the major reason for the relatively small number of female mathematicians was that "math is not considered feminine" (Burton, 1978).

Compounding this perception of mathematics as a male domain is the belief found among many women that "intellectual excellence is not consistent with stereotypic-female sex-role expectations" (Fennema and Sherman, 1976). This belief can adversely affect women's intellectual development and lead to a fear of success (or a motive to avoid success) in intellectual areas traditionally assumed to be male. As mathematics has until recently been considered a male domain, women may believe that high achievement could result in unpopularity (Toronto Board of Education, 1983). Some studies have confirmed this hypothesis, while others have not. Nevertheless, if some female students do harbour such a fear of success, it could adversely affect their achievement and perhaps their willingness to study mathematics.

The interest and encouragement shown to learners of mathematics by parents and teachers has also been found to influence the course selection patterns of male and female students. The more supportive parents are of their children's endeavours, the more confidence the students have in their ability to do well; the more importance parents place on the subject, the greater the likelihood that the students will continue on in that subject. While the link between parental attitudes and participation in mathematics is not as strong as for some of the previously-mentioned factors, it has nevertheless proven to be significant. Research has shown that, in general, parents are more supportive of their sons as learners of mathematics than their daughters and that they tend to believe that the study of mathematics is more important for men than for women.

The support and encouragement provided by mathematics teachers is also important in determining a student's attitude towards that subject. In fact, Fennema states that "teachers are the most important educational influence on students' learning of mathematics" (Toronto Board of Education, 1983). Although a number of studies have revealed no differential treatment of female

and male students in mathematics classes, others have found teachers to have higher expectations for their male students and to see mathematics as being a less appropriate discipline for women (Burton, 1978). Becker studied high school geometry classes and concluded that "the students were learning mathematics in an environment that sex-typed the subject as male, that provided more formal and informal reward and support in mathematics for males, and that provided males more outlets for classroom academic achievement and recognition. Whereas males were provided a good cognitive and affective environment in which to learn mathematics, females, relatively speaking, were treated with benign neglect" (Toronto Board of Education, 1983). While the results from studies of teachers' attitudes are inconclusive and vary from class to class, it is not unreasonable to suggest that in some instances teachers unintentionally demonstrate greater support and encouragement for males and thus may discourage females from pursuing mathematics.

In an attempt to offset the effects of many of the socio-cultural and educational factors which discourage women from studying mathematics, a number of intervention strategies have been devised. These strategies include the modification of subject matter and teaching methods to make mathematics more appealing to girls; discussions with parents and teachers in which the importance of a strong mathematical background for students of both sexes is stressed; presenting female students with appropriate role models; and streaming mathematics classes by sex.

A number of experiments have been carried out in which single-sex mathematics classes have been created for female students. The rationale behind these initiatives has been the belief that without male students in their mathematics classes, females become less hesitant to work to the full of their ability: they need not be concerned about appearing "unfeminine" in front of their male peers by seeming too bright or ambitious. Moreover, all-girl classes encourage the development of strong peer support groups which are important in changing the perception of mathematics as a male domain and affirming the appropriateness of mathematics for women.

In one experiment, a summer accelerated mathematics course was held for gifted boys and girls about to enter grade 7 (Brody and Fox, 1980). Although most were placed in co-educational classes, one class was composed solely of female students. The progress of the students who completed the program was monitored until the end of grade 11: at that time, 42% of the girls who had been in the all-girl class were accelerated one year or more in mathematics. The corresponding figures for the girls and boys in the co-educational classes were 8% and 46% respectively. These results seem to indicate that female students who are involved in a single-sex class at some point in their schooling are more likely than their counterparts in co-educational classes to accelerate in mathematics.

In another study which involved an all-girl mathematics class, the investigators stated that the "all-girl nature of the class was . . . appreciated by both the girls and their parents" (Tobin and Fox, 1980). No data were collected, however, to show whether or not the class was effective in encouraging the students to continue their study of mathematics beyond the level required in high school. A similar study was also carried out at the university level

with positive results ("having only women in the class seemed to be an important factor in the success of the project"), although again no quantitative data were gathered (MacDonald, 1980).

Segregating classes by sex has also been attempted in some science courses where similar discrepancies between the participation rates of males and females have been found. The results of these experiments and data from all-girl schools indicate that "girls who are taught science, engineering and technical subjects in all-girl schools or girls classes succeed in these areas much more frequently than girls in co-educational classes" (Sheinen, 1982). Moreover, it has been suggested that girls who are vastly outnumbered by boys in science classes may assume that women are inappropriate and unwelcome participants in such fields and thus be discouraged from continuing to study science. "There is a body of literature showing that girls in co-educational schools are both more likely to be offered physics and less likely to take it than in single sex schools" (Scott, 1982).

Although research into the effectiveness of all-girl classes has been limited and the results often qualitative in nature, it has lent support to the concept of segregation of mathematics classes by sex. Investigators have yet to uncover any evidence to suggest that segregation is detrimental to the achievement or attitude of female mathematics students.

In many of the experimental mathematics classes an attempt was made to make the subject matter more appealing to female students. It was felt that much of the emphasis and many of the techniques used in regular mathematics classes were not geared to the interests and learning styles of girls. In one of the segregated classes "the structure was informal, instruction being individualized and in small groups. Co-operative activities rather than competitive ones were stressed. Whenever possible, the teachers emphasized the ways in which mathematics could be used to solve problems. Some traditional word problems were rewritten in an attempt to make them more socially appealing" (Brody and Fox, 1980). In another program emphasis was placed on the importance of mathematics in occupations concerned with solving problems of a social nature. "Using the research evidence that girls seem to have preference for social occupations and social values, one objective of the course was to show that meaningful relationships between mathematics and humanity's ability to solve its social problems, as well as its theoretical problems, do exist." (Tobin and Fox, 1980).

Researchers who have been involved in developing intervention strategies, whether with segregated or regular classes, all stress the importance of presenting female students with role models. Exposure to adults who lead satisfying lives both as women and as professionals in math-dependent careers provides proof of the appropriateness of mathematics as a field of study for both females and males. In fact, a 1976 National Science Foundation project designed to assess strategies used to increase women's participation in mathematics and science concluded that the presence of role models during the high school years appeared to be the most effective (Fox, 1976). While these role models may consist of guest speakers such as female engineers, architects, physicists and mathematicians, some studies even suggest that it is important that a good number of the teachers themselves be female. Other

studies show that the sex of the teacher is irrelevant as long as she/he is supportive of female students. It seems likely that the attitudes and behaviours of teachers, not their sex per se, are critical.

In one study an attempt was made to foster girls' interest in studying science by changing parents' and teachers' attitudes towards them as learners of that subject (Fischer, 1982). Discussions were held with parents and teachers of elementary school girls where the importance of science for women was stressed. One year later, the female students showed improved performance at, and enjoyment of creative scientific tasks. Researchers have also suggested that special in-service training programs be developed for teachers of science. "The programs should help teachers examine their own expectations for girls and boys in science, and to develop an awareness of sociocultural factors which contribute to girls' underachievement in this area. Issues of classroom management, student-teacher interactions and the presentation of science subject materials should be discussed and related to sex differences in achievement" (Erickson, 1982). Obviously such recommendations would be equally appropriate for mathematics teachers.

Knowledge of mathematics is an essential requirement for a wide variety of careers. When students elect not to study it beyond minimum high school requirements, they are severely limiting the educational and occupational opportunities available to them. A large number of high school students are currently making such a decision and among them, a particularly high proportion of females. Studies have in fact shown that as females proceed through the grades, their participation in mathematics declines more sharply than that of males. As research has failed to prove that there are any sex differences in innate mathematical ability, investigators have begun to turn towards environmental factors to explain the discrepancies in participation rates. Here the results have proven to be more conclusive: factors such as fear of success, perception of mathematics as a male domain, attitudes of significant others, confidence in learning mathematics, mathematics anxiety and perceived usefulness of mathematics have all been shown to influence a girl's decision as to whether or not to study mathematics. Intervention strategies have been developed to offset the influence of such factors. While their use has not been widespread, they have been proven to be effective and include such innovations as the modification of subject matter and teaching methods to make mathematics more appealing to girls; discussions with parents and teachers in which the importance of a strong mathematical background for students of both sexes is stressed; presenting female students with appropriate role models; and streaming mathematics classes by sex.

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APPENDIX B

Relationship Between Mathematics Achievement and Attitudes

Much of the literature regarding the study of mathematics suggests that there is a close relationship between achievement and attitude: the higher the student's level of achievement, the more likely she/he is to have positive attitudes, and vice-versa. The extent to which this relationship is one of cause and effect, however, has yet to be determined.

With the data gathered to assess the effectiveness of sex-segregated mathematics classes, it was decided to conduct an analysis to determine whether or not there was a relationship between achievement and attitudes for the students in our sample. An attempt was made to match students' grade 9, 10 and C.A.T. marks with the results from their May 1985 attitude surveys by requesting that students put their names on the survey. At the comparison school, over 80% of the students did so, while at A.Y. Jackson the figure was slightly less than two-thirds, probably due to the nature of their questionnaire (i.e. the questions regarding their reactions to the sex-segregated classes).

A series of tests was carried out to determine to what extent those students for whom achievement could be matched with attitude were representative of the entire sample. As might have been expected, those students most likely to put their names on the survey were higher achievers and held more positive attitudes towards mathematics, especially at A.Y. Jackson. Any conclusion drawn regarding the relationship between attitude and achievement must therefore take into account the fact that the sample is somewhat biased towards students who have higher achievement in mathematics and more positive attitudes towards it.

Pearson correlation coefficients were used to establish the relationship between achievement and the various attitude subgroups. Significant positive correlations were found between achievement and the following scales:

- mathematics anxiety
- confidence in learning mathematics
- teacher attitude
- mathematics usefulness
- effectance motivation in mathematics

There appeared to be no relationship between achievement and attitude towards success in mathematics, perception of mathematics as a male domain, and mother/father attitude.

APPENDIX C

Student Reactions to Sex-Segregated Mathematics Classes

	Pre		Post	
	M. %	F. %	M. %	F. %
• attitudes and achievement are not affected by segregated classes - they depend on the individual's ability and motivation, not on who's in her/his class	36	43	25	31
• segregated classes are unnecessary, boring, a bad idea - mixed classes are better, more interesting	20	19	35	16
"teenagers should be taught to deal responsibly and maturely with problems involving the opposite sex, not removed from it" (f)				
"it's very sexist" (f)				
• students feel more comfortable, relaxed in segregated classes. They don't have to worry about being embarassed by asking questions, giving answers in front of members of the opposite sex	4	28	7	32
"sometimes girls just don't want to bother saying anything in a math class because of giggles we get from the guys. Girls usually get put down when getting bad marks and when the guys say something about it or tease, they just give up trying" (f)				
"girls feel more comfortable in answering questions and speaking out if they have any problems" (f)				
"segregated classes are effective because students have a better attitude about going to class. Girls are more open. They seem more enthusiastic [. . .] Girls feel freer in getting help. Feel loose and comfortable" (f)				
"in mixed classes boys always answered the questions, girls didn't get a chance" (f)				
"don't get embarassed when asking a question or answering one wrong" (m)				
"no longer intimidated by girls" (m)				
• fewer distractions, easier to concentrate on your work	24	11	14	4

	Pre		Post	
	M. %	F. %	M. %	F. %
• classes are noisier, more unruly without the opposite sex/students work better in mixed classes, try to impress the opposite sex	1	5	14	14
"boys help you work harder because you don't want them to think you're dumb. With segregated classes girls don't bother working hard - they're only proving themselves smart to girls (which is not as important as proving it to guys)" (f)				
"girls talk, talk, talk - most don't accomplish anything as they don't pay attention. The boys quiet them down" (f)				
"you would try harder to make yourself look good in front of the girls" (m)				
"[segregated classes] result in a lot of wasted time, especially in the area of talking. If girls were here they would probably have a big influence in keeping classes quiet" (m)				
• segregated classes are a good idea, would like them to continue	2	11	4	7
• effect of segregated classes depends on the individual - some have found them helpful, while to others they have made no difference	1	11	-	12
• haven't given segregated classes much thought/don't care one way or another	2	4	4	2
• more challenge, competition in mixed classes	2	3	2	5
"more challenging for a really smart math student" (f)				
"since boys are in fact better than girls in math, it would be more challenging" (f)				
• achievement has improved this year			1	10
• segregated classes haven't helped academically - marks have gone down			4	6

	Pre		Post	
	M. %	F. %	M. %	F. %
. segregated classes imply that girls aren't as capable of doing well in mathematics as boys			3	6
"segregation is more a put down to girls than any insult a guy could give a girl in class - it says boys are better than girls and it's not true" (f)				
"degrading to the females because what you're saying by doing this is that you aren't smart enough to work with the male students" (m)				
. students relate better to teachers of their own sex, closer relationship with the teacher	2	1	1	4
"feeling of closeness" (f)				
"like it when the teacher speaks to us and recognizes us as women. She wouldn't be able to open up to us if there were any men in the class" (f)				
. fun being in a class with only people of your own sex			3	3
"there are times we talk about things and have fun which we can't do when guys are in the class" (f)				
. perhaps helpful for some students but didn't make much difference for me			2	4
. students are trying harder to do well	2	3	-	1
. marks haven't been affected			2	3
. classes should be segregated by ability, not sex	3	-	-	2
. feel more confident about ability to do well in math	-	-	-	4
. segregation has made girls feel insecure, inferior	2	2	-	-
. may benefit girls although does not make any difference for boys			3	-
. "the working attitude is different when we are segregated. There is no tendency to show off (boys) or to play dumb (girls)" (f)			1	1

	Pre		Post	
	M. %	F. %	M. %	F. %
. have come to view segregated classes more positively "my thoughts towards segregated math classes have changed in this trial period. I enjoy these classes and receive good marks. I think it is extremely effective in improving students' attitudes" (m)			1	1
. segregated classes are no different from any other			2	-
. was a good experiment but should be discontinued			1	1
. students should have a choice as to whether or not they participate in segregated classes			1	1
. could help some, while it hurts others			1	1
. boys are generally smarter			1	1
. "by doing this experiment it has made girls realize the importance of math. I have heard girls discussing their grades in math and teachers, etc. more than before. By bringing this problem out into the open the students are trying to work harder and their parents are encouraging them more. Also, in this situation some girls [. . .] may feel that boys are being regarded as smarter than girls and will try to work harder to prove to themselves (maybe others) that it isn't true". (f)				
. "shows that the teachers care about what the students think so the students will care more and want to do well" (f)				
. "the girls in my math class are just as intimidating as the boys were the previous year" (f)				
. "don't like the way the girls are blamed for the segregated classes. This probably makes the guys think we are wimps. The school board would have been better off telling us it was being done instead of giving us reasons for it" (f)				

APPENDIX D

Parent Reactions to Sex-Segregated Mathematics Classes

	Parents of Males %	Females %	Total %
• attitudes and achievement are not affected by segregated classes - they depend on student motivation, ability and teacher competence	46	38	42
• students are less hesitant to answer questions, express difficulties and seek extra help. There is less pressure and therefore classes are more relaxed, enjoyable	13	20	16
"at this age group, girls might feel that being a bright math student would intimidate boys and therefore make her a social outcast. Without the 'social' pressure there is a freedom to express and achieve" (parent of female)			
"without boys in the class to 'put you down' when you ask a question, girls feel freer to ask questions. My daughter feels better without the boys around and asks more questions and feels better about math" (parent of female)			
"less shy to ask questions - girls seem more at ease without the boys taunting and teasing" (parent of female)			
"no embarassment about asking questions in front of girls"(parent of male)			
"less likely to worry about looking 'cool' and they are more likely to get on with learning and asking questions when they need to" (parent of male)			
• segregated classes are unnecessary, a bad idea	16	17	16
"don't approve of segregation unless absolutely necessary - i.e. for retarded students" (parent of male)			
"cannot change an attitude that is reinforced as early as grades 3 - 6. Should be dealt with earlier" (parent of female)			
"do not believe that segregated math classes are applicable for students of today. Perhaps it would have been a good idea 10-15 years ago but today's female student does not feel that her sex is a barrier to her career or subject choice" (parent of female)			

	Parents of Males %	Females %	Total %
• segregated classes are a good idea, should be continued	13	12	13
• fewer distractions, easier to concentrate	14	12	13
• attitudes have improved, students are more confident	10	8	9
"my child has always done well in math, but has just begun to feel that she is good at it" (parent of female)			
"have had fewer 'math trauma' sessions at home this year" (parent of female)			
"my child has developed a more serious attitude towards math" (parent of male)			
• achievement has improved, marks are higher this year	6	9	7
• would be interested in seeing the results of this study/what's the evidence to support segregation of classes by sex?/to prove any merit, a school with a solid control group is needed	7	6	7
• classes are noisier, more unruly without the opposite sex/students try harder in mixed classes in order to impress opposite sex	7	5	6
"maybe with the opposite sex in their class, they strive a little more to avoid embarassment" (parent of male)			
"feeling of trying harder (to not be such a dummy) when there are boys around" (parent of female)			
• other subjects should be segregated too (i.e. computer science, sciences, English)	4	6	5
"would like to see computer classes segregated as well. Girls suffer from 'lack of self-esteem' in traditional male-dominated subjects. Boys dominate the class - girls hold back" (parent of female)			
• marks have not changed	-	11	5
• segregated classes are most helpful for very poor students/ depends on individual	-	9	4

	Parents of Males %	Females %	Total %
• would rather see classes streamed by ability than sex	3	5	4
• students must get used to working with members of the opposite sex	6	3	4
"young people must learn to live, work and function in a social environment which contains members of the opposite sex. They must learn to do this at the earliest opportunity. Segregation of any class simply delays this adaptation to living in equality with each other" (parent of male)			
• less challenge, competition in segregated classes - a negative feature	3	6	4
• segregated classes imply that females are not as good in mathematics as males	7	-	4
• boys are generally better in mathematics than girls	6	3	4
• less competition in segregated classes - a positive feature	3	2	2
• better rapport with teacher	1	3	2
• did not do as well in math this year	-	5	2
• emphasis should be on informing students and parents of the importance of studying math	1	2	1
• nothing lost	-	2	1
• would appear that more attention was paid to raising the girls' marks at the expense of boys' marks	1	-	1

Student Questionnaire
1984-85

A. SEX: Male ☐ Female ☐

B. Please read each of the following statements carefully and indicate the extent to which you agree or disagree with each statement.

	Strongly Agree 1	2	3	4	5	Strongly Disagree 6
1. Being regarded as smart in mathematics would be a great thing.	☐	☐	☐	☐	☐	☐
2. Studying mathematics is just as appropriate for women as for men.	☐	☐	☐	☐	☐	☐
3. I get a sinking feeling when I think of trying hard math problems.	☐	☐	☐	☐	☐	☐
4. My mother wouldn't encourage me to plan a career which involves math.	☐	☐	☐	☐	☐	☐
5. I'm no good in math.	☐	☐	☐	☐	☐	☐
6. My teachers have encouraged me to study more mathematics.	☐	☐	☐	☐	☐	☐
7. I expect to have little use for mathematics when I get out of school.	☐	☐	☐	☐	☐	☐
8. I don't understand how some people can spend so much time on math and seem to enjoy it.	☐	☐	☐	☐	☐	☐
9. My father thinks that mathematics is one of the most important subjects I have studied.	☐	☐	☐	☐	☐	☐
10. It would make me happy to be recognized as an excellent student in mathematics.	☐	☐	☐	☐	☐	☐
11. Males are not naturally better than females in mathematics.	☐	☐	☐	☐	☐	☐
12. I usually have been at ease during math tests.	☐	☐	☐	☐	☐	☐

		Strongly Agree 1	2	3	4	5	Strongly Disagree 6
13.	My mother has shown no interest in whether or not I take more math courses.	☐	☐	☐	☐	☐	☐
14.	I can get good grades in mathematics.	☐	☐	☐	☐	☐	☐
15.	Getting a mathematics teacher to take me seriously has usually been a problem.	☐	☐	☐	☐	☐	☐
16.	Mathematics is of no relevance to my life.	☐	☐	☐	☐	☐	☐
17.	I am challenged by math problems I can't understand immediately.	☐	☐	☐	☐	☐	☐
18.	My father has strongly encouraged me to do well in mathematics.	☐	☐	☐	☐	☐	☐
19.	I'd be happy to get top grades in mathematics.	☐	☐	☐	☐	☐	☐
20.	I would have more faith in the answer for a math problem solved by a man than a woman.	☐	☐	☐	☐	☐	☐
21.	Mathematics usually makes me feel uncomfortable and nervous.	☐	☐	☐	☐	☐	☐
22.	My mother thinks that mathematics is one of the most important subjects I have studied.	☐	☐	☐	☐	☐	☐
23.	I'm not the type to do well in math.	☐	☐	☐	☐	☐	☐
24.	Math teachers would think I wasn't serious if I told them I was interested in a career in science and mathematics.	☐	☐	☐	☐	☐	☐
25.	Mathematics will not be important to me in my life's work.	☐	☐	☐	☐	☐	☐
26.	Mathematics is enjoyable and stimulating to me.	☐	☐	☐	☐	☐	☐
27.	My father wouldn't encourage me to plan a career which involves math.	☐	☐	☐	☐	☐	☐
28.	It would be really great to win a prize in mathematics.	☐	☐	☐	☐	☐	☐

		Strongly Agree 1	2	3	4	5	Strongly Disagree 6
29.	I would trust a woman just as much as I would trust a man to figure out important calculations.	☐	☐	☐	☐	☐	☐
30.	My mind goes blank and I am unable to think clearly when working mathematics.	☐	☐	☐	☐	☐	☐
31.	My mother has strongly encouraged me to do well in mathematics.	☐	☐	☐	☐	☐	☐
32.	Generally, I have felt secure about attempting mathematics.	☐	☐	☐	☐	☐	☐
33.	My math teachers have been interested in my progress in mathematics.	☐	☐	☐	☐	☐	☐
34.	Mathematics is a worthwhile and necessary subject.	☐	☐	☐	☐	☐	☐
35.	Figuring out mathematical problems does not appeal to me.	☐	☐	☐	☐	☐	☐
36.	My father has shown no interest in whether or not I take more math courses.	☐	☐	☐	☐	☐	☐
37.	I don't like people to think I'm smart in math.	☐	☐	☐	☐	☐	☐
38.	Girls can do just as well as boys in mathematics.	☐	☐	☐	☐	☐	☐
39.	I usually have been at ease in math classes.	☐	☐	☐	☐	☐	☐
40.	For some reason even though I study, math seems unusually hard for me.	☐	☐	☐	☐	☐	☐
41.	My teachers think I'm the kind of person who could do well in mathematics.	☐	☐	☐	☐	☐	☐
42.	Knowing mathematics will help me earn a living.	☐	☐	☐	☐	☐	☐
43.	I do as little work in math as possible.	☐	☐	☐	☐	☐	☐
44.	People would think I was some kind of a browner if I got A's in math.	☐	☐	☐	☐	☐	☐

		Strongly Agree 1	2	3	4	5	Strongly Disagree 6
45.	I would expect a woman mathematician to be a masculine type of person.	☐	☐	☐	☐	☐	☐
46.	I haven't usually worried about being able to solve math problems.	☐	☐	☐	☐	☐	☐
47.	I am sure that I can learn mathematics.	☐	☐	☐	☐	☐	☐
48.	It would make people like me less if I were a really good math student.	☐	☐	☐	☐	☐	☐
49.	Girls who enjoy studying math are a bit peculiar.	☐	☐	☐	☐	☐	☐
50.	If I had good grades in math, I would try to hide it.	☐	☐	☐	☐	☐	☐
51.	It's hard to believe a female could be a genius in mathematics.	☐	☐	☐	☐	☐	☐

C. Please consider the following list of careers and indicate:

i) which career is most closely related to the **career you would most like to have** if there was nothing to limit or prevent you

ii) which **career** you actually **expect to have** in the future

Read the entire list carefully before making your selection.

	Career I would most like to have (Select one)	Career I expect to have (Select one)
Computer Programmer	☐	☐
Real Estate Agent	☐	☐
Veterinarian	☐	☐
Lawyer	☐	☐
Registered Nurse	☐	☐
Elementary School Teacher	☐	☐
Flight Attendant	☐	☐
Photographer	☐	☐
Forester	☐	☐
Personnel Director	☐	☐
Manager of a Business, Bank	☐	☐
Chiropractor	☐	☐
Social Worker	☐	☐
Dental Assistant	☐	☐
Sales Person	☐	☐
Dentist/Orthodontist	☐	☐
Homemaker	☐	☐

(list continued on next page)

	Career I would most like to have	Career I expect to have
Pilot	☐	☐
Interior Decorator	☐	☐
Architect	☐	☐
Engineer	☐	☐
Doctor	☐	☐
Secretary	☐	☐
Priest/Minister/Rabbi	☐	☐
Musician/Artist/Actress/Actor	☐	☐
Police Officer	☐	☐
Beautician	☐	☐
Secondary School Teacher in _____ (subject)	☐	☐
Writer/Editor/Journalist/Reporter	☐	☐
Accountant	☐	☐
Psychologist	☐	☐
Physio Therapist	☐	☐
Hotel Manager	☐	☐
University Professor (Area _____)	☐	☐
Stockbroker	☐	☐
Other: _____ (please specify)	☐	☐
_____	☐	☐

D. 1. Do you think that segregated classes are effective in improving students' attitudes towards mathematics?

Yes ☐ No ☐ Don't know ☐

Please explain.

_____

_____

_____

2. Do you think that segregated classes are effective in improving students' achievement in mathematics?

Yes ☐ No ☐ Don't know ☐

Please explain.

_____

_____

_____

3. In general, have you found segregated classes to be a positive experience?

_____

_____

_____

4. Do you have any other comments about the concept of segregating math classes by sex?

_____

_____

_____

5. Are you planning to take mathematics next year?

Yes ☐ No ☐

If yes, what level?

Advanced ☐

General ☐

If no, why not?

_____

_____

_____

Name: _____

THANK YOU FOR YOUR CO-OPERATION

APPENDIX F

STUDENT QUESTIONNAIRE ITEMS BY SCALE

ATTITUDE TOWARD SUCCESS IN MATHEMATICS

It would make me happy to be recognized as an excellent student in mathematics.

I'd be happy to get top grades in mathematics.

It would be really great to win a prize in mathematics.

Being regarded as smart in mathematics would be a great thing.

People would think I was some kind of a browner if I got A's in math.

If I had good grades in math, I would try to hide it.

It would make people like me less if I were a really good math student.

I don't like people to think I'm smart in math.

MATHEMATICS AS A MALE DOMAIN

Studying mathematics is just as appropriate for women as for men.

I would trust a woman just as much as I would trust a man to figure out important calculations.

Girls can do just as well as boys in mathematics.

Males are not naturally better than females in mathematics.

It's hard to believe a female could be a genius in mathematics.

I would have more faith in the answer for a math problem solved by a man than a woman.

Girls who enjoy studying math are a bit peculiar.

I would expect a woman mathematician to be a masculine type of person.

MATHEMATICS ANXIETY

I haven't usually worried about being able to solve math problems.

I usually have been at ease in math classes.

I usually have been at ease during math tests.

Mathematics usually makes me feel uncomfortable and nervous.

I get a sinking feeling when I think of trying hard math problems.

My mind goes blank and I am unable to think clearly when working mathematics.

CONFIDENCE IN LEARNING MATHEMATICS

Generally, I have felt secure about attempting mathematics.

I am sure that I can learn mathematics.

I can get good grades in mathematics.

I'm no good in math.

I'm not the type to do well in math.

For some reason even though I study math seems unusually hard for me.

TEACHER

My teachers have encouraged me to study more mathematics.

My teachers think I'm the kind of person who could do well in mathematics.

My math teachers have been interested in my progress in mathematics.

Getting a mathematics teacher to take me seriously has usually been a problem.

Math teachers would think I wasn't serious if I told them I was interested in a career in science and mathematics.

USEFULNESS OF MATHEMATICS

Knowing mathematics will help me earn a living.

Mathematics is a worthwhile and necessary subject.

Mathematics is of no relevance to my life.

Mathematics will not be important to me in my life's work.

I expect to have little use for mathematics when I get out of school

EFFECTANCE MOTIVATION IN MATHEMATICS

Mathematics is enjoyable and stimulating to me.

I am challenged by math problems I can't understand immediately.

Figuring out mathematical problems does not appeal to me.

I don't understand how some people can spend so much time on math and seem to enjoy it.

I do as little work in math as possible.

MOTHER

My mother has strongly encouraged me to do well in mathematics.

My mother thinks that mathematics is one of the most important subjects I have studied.

My mother wouldn't encourage me to plan a career which involves math.

My mother has shown no interest in whether or not I take more math courses.

FATHER

My father has strongly encouraged me to do well in mathematics.

My father thinks that mathematics is one of the most important subjects I have studied.

My father wouldn't encourage me to plan a career which involves math.

My father has shown no interest in whether or not I take more math courses.

A.Y. Jackson Grade 10 Advanced Mathematics

Parent Questionnaire

1984-85

1. My son ☐ , daughter ☐ is enrolled in grade 10 advanced mathematics.
(please check)

2. Are you aware that all grade 10 advanced mathematics classes at A.Y. Jackson Secondary School are segregated by sex?

Yes ☐ No ☐

3. Do you feel that segregated classes are effective in improving students' attitudes towards mathematics?

Yes ☐ No ☐ Don't know ☐

Please explain: _____

_____

_____

4. Do you feel that segregated classes are effective in improving students' achievement in mathematics?

Yes ☐ No ☐ Don't know ☐

Please explain: _____

_____

_____

5. In general, have segregated classes been a positive experience for your child?

Yes ☐ No ☐ Don't know ☐

Please explain: _____

_____

_____

6. Are there any other comments you'd like to make regarding segregated mathematics classes?

_____

_____

_____

7. How important is it for your child to study mathematics?

Very important		Somewhat important		Not at all important
☐	☐	☐	☐	☐

8. Have you ever discussed career possibilities with your child?

Yes ☐ No ☐

Name: _____

THANK YOU FOR YOUR CO-OPERATION

Please return the completed questionnaire
in the attached self-addressed envelope
by 12 June 1985

ER&ES
May/85

A. Y. JACKSON TEACHER INTERVIEW SCHEDULE

1. Background Information:

   - Sex
   - How many years have you been teaching?
   - How many years have you been teaching at A. Y. Jackson?
   - Where were you before that?
   - How many years have you been teaching math?
   - Are you teaching both segregated and mixed classes this year?

2. Were you ever aware of any differences between the attitudes and achievement levels of male and female students in your math classes? If yes, please explain.

3. What effect, if any, have segregated classes had on student
   - attitudes
   - confidence
   - expectations
   - achievement

4. Have your teaching style, strategies and expectations changed in any way as a result of the segregated classes?

5. Do you feel that segregated classes are worthwhile? Should they be continued? Do you have any changes to suggest?

6. Any other comments?